Insulation Management and Its Value to Industry

Michael J. Lettich, MJL Consulting/National Insulation Assocation

Just look at any chemical, petrochemical, or petroleum refining facility. Much of what you might see is insulated piping, equipment, and vessels. It sure looks like there is a lot of it. As a matter of fact, there is a great deal of insulated pipe, equipment, tanks, and vessels. As an example, let's consider a "typical" mid-size chemical plant and oil refinery. A mid-sized chemical manufacturing plant might contain more than 61 miles of insulated piping and more than six football fields (270,000 square feet [ft^2]) of insulated equipment, vessels, and tanks. A medium-sized oil refinery contains 356 miles of insulated piping and more than 32 football fields (1.4 million ft^2) of insulated equipment, vessels, and tanks.

It seems clear that insulation serves an important role in the operation of all chemical, petrochemical, and oil refining facilities. But why is it important?

- **Process control is first and foremost.** Insulation helps retard the flow of thermal energy into or out of a process, keeping temperatures stable, allowing chemical reactions to proceed normally and safely to manufacture the chemical and oil products.
- **Energy conservation is next.** Without insulation, thermal energy would escape uncontrollably to the atmosphere, wasting billions of dollars. Figure 1 illustrates the energy loss from an uninsulated 4-inch pipe versus one insulated with 2 inches of insulation and covered with aluminum jacket.
- **Freeze protection is important for facilities in northern climates.** Without adequate insulation on critical service equipment that supplies cooling or fire protection water, steam condensate, and other aqueous solutions, they would freeze, preventing them from performing the service they were intended to do. The freezing of this equipment also results in rupture and breakage of pipe and equipment

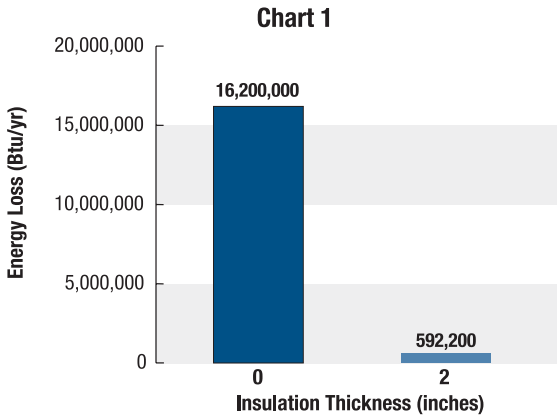

Figure 1. Thermal energy loss for bare versus insulated 4-inch pipe.

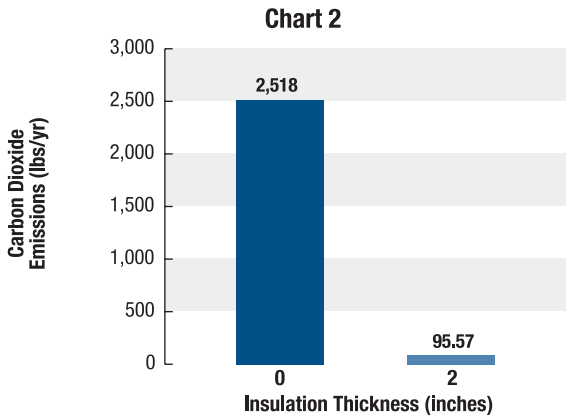

Figure 2. Carbon dioxide (CO_2) emissions comparison for bare versus insulated 4-inch pipe.

Note: Charts 1 and 2 – Data for 4-inch carbon steel pipe at 350˚F
Source: NAIMA 3E Plus® Computer Program

because of water's unique property to expand when frozen. This results in millions of dollars of damage along with the potential for serious environmental and personnel safety problems.

- **Personnel protection from burn hazards provides an important insulation service.** Much of the insulated pipe and equipment in a chemical plant or oil refinery operate at temperatures ranging from 200˚F to more than 1,000˚F. These are located near where plant employees and contract personnel work on a daily basis. Insulation is frequently the only barrier keeping personnel safe from these hazards.
- **Emissions control, although frequently not recognized, is another service insulation provides to an industrial plant.** Figure 2 shows the emissions loss from the same 4-inch pipe, comparing bare versus 2 inches of insulation.

	Mid-Size Chemical Plant	150,000 bpd Refinery
Insulation Damage	19.2%	21.3%
Corrosion Under Insulation (CUI)	$250,000 annually	$500,000 annually
Energy Loss ($5/MMBtu)	$1,829,000 annually	$10,664,000 annually

Figure 3. Typical damage and costs from poorly maintained insulation in industrial facilities.

Industry Appreciates Insulation—Or Does It?

With all the essential service insulation performs for industry, it must be an important element in each facility's maintenance program …right? Well, let's look at those chemical plant and oil refinery examples discussed earlier. Figure 3 shows the typical damage present, the problems created, and their costs. Another way to look at the scope of the problem is in terms of asset value. Take that typical, mid-size chemical plant with existing damages, assuming an invested value of $500 million. A normal chemical plant contains from 6% to 10% of its asset value in insulation systems. This means there is between $30 million and $50 million worth of insulation damage to this facility. With the cost of energy from about $4 per million British thermal units ($4/MMBtu) to more than $10/MMBtu, repairs to many of these damaged insulation systems would yield from 30% to more than 300% return on the investment (ROI). With this kind of damage and the potential for excellent payback once repaired, it looks like insulation maintenance is not managed as well as

Photo 1. Bare pipes.

Photo 2. Cosmetic damage on pipes.

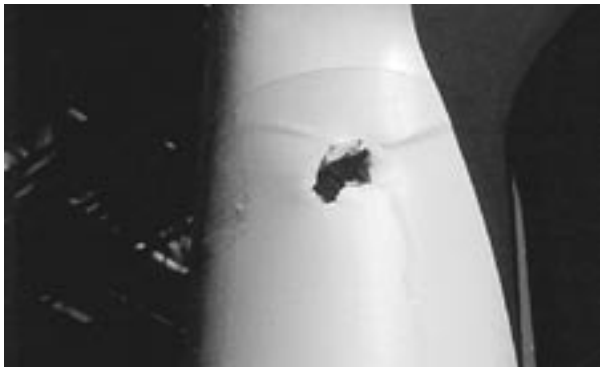

Photo 3. Jacket damage.

Photo 4. System patch.

Photo 5. Sealant failure.

Photo 6. System failure.

it should be. It also does not seem to be considered very important, despite compelling evidence. Why? Quoting a fellow consultant and friend, V. S. Pignolet of Balmert Consulting: "For something to get fixed, it first must be noticeable. Then the level of damage must be objectionable." The abundance of insulated pipe and equipment that surrounds industrial facility managers makes it difficult to recognize the impact of what looks like such a small amount of damage. However, often the biggest reason is that much of the damage is either not noticed or viewed as not important. Insulation damage ranges from cosmetic, such as staining, to completely bare equipment. Examples of each type of damage are illustrated in Photos 1 through 6.

A good example of "not noticed" was an insulation assessment I performed at a chemical plant in the Texas Gulf Coast. The plant's management was concerned about the quality and capacity of their steam delivery system. Often, the steam pressure was dramatically reduced and there was an excessive amount of condensate within the system at the end of the main utilities distribution pipe rack. As a result, those production manufacturing facilities were having a more difficult time operating efficiently.

Photo 7. Midwest chemical plant with damaged vapor retarder.

As I started my assessment survey, I interviewed personnel from the utilities area. These personnel indicated that each time it rained they had to add about 25% more steam generating capacity in order to meet the demand. Since this was the Texas Gulf Coast, the plant saw rain.

Looking at the utilities distribution pipe rack from the ground showed only incidental damage to these steam pipes. However, once I gained access to the top of the pipe rack, the picture changed. These steam lines were installed with glass fiber insulation covered with corrugated aluminum jacketing (great for trapping water and diverting it into the insulation when used on horizontal runs). Over the years, maintenance activity, storms, salt in the air from the Gulf Coast only a few miles away, and the mildly corrosive atmosphere resulted in numerous small holes in the aluminum jacketing. The result? Each time it rained, nearly the entire run of steam lines in this pipe rack was ruining the insulation efficiency and condensing the steam before it could get to many of the process facilities. The project designed to upgrade this damage yielded more than 150% ROI for the energy savings alone. In addition, each production facility found a more reliable source of steam with less difficulty efficiently operating their facilities.

A case of "not realizing" was an insulation assessment I performed at a chemical plant in the Midwest. This plant operates much of its facility well below 0˚F, with some in the cryogenic ranges below minus 100˚F. The insulation system was cellular glass with an applied "asphalt cutback" vapor retarder and aluminum jacketing. At a casual glance most of the insulation systems looked intact. However, most of the piping, equipment and vessels showed extensive condensation and mildew growth on the jacketing (Photo 7). Over time (with the help from some maintenance and shutdown activity damage), the vapor retarder had failed, filling the system with moisture.

Figure 4 shows the loss of insulation efficiency as a result. Again, with refrigeration energy costs of almost $40/MMBtu, a project with excellent ROI was developed. Also, the refrigeration units could run during the peak mid-summer times without reaching capacity limits.

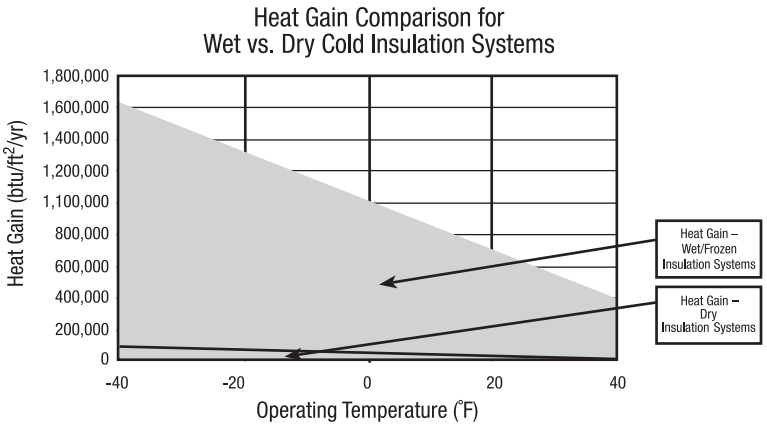

Figure 4. One square foot insulated with 4 inches of insulation.

Maintenance: Still A Reactive Program

Another reason so much of industry's insulation systems remain damaged is the manner they are repaired. Insulation maintenance remains a very reactive program. Simply stated, this means that once it gets found, it gets fixed. The consequences of this type of maintenance are many.

- Usually only the most damaged, highly visible, items get fixed. As a result, every $1 that would have been spent to repair the insulation with minimal damage (e.g. sealant or jacket repair) will cost from $10 to more than $50. This does not help to stretch already reduced maintenance budgets!
- Each scope of work is small, leading almost invariably to low insulator work efficiency and high cost. The insulator must mobilize, secure all necessary permits, and get to the work site. This element of cost is essentially fixed, meaning it will take about the same amount of money to fix 3 feet as it would 30 feet of insulation damage in any one area. I have performed and seen studies that reflect from 20% to more than 300% less insulator work efficiency for work performed this way. Once again those precious maintenance budgets are getting strained!
- Many damaged areas are never even seen at all so are never fixed. Hard to see areas, such as congested, multi-tier pipe racks or the highest elevations of a facility are good examples. Personnel seldom travel there and have limited visibility. If they do so, needed insulation repairs are overlooked.
- Doing repairs in this manner makes it extremely difficult to identify the work that has been accomplished. As a result, a busy operations manager, who probably does not fully understand the benefits of insulation maintenance, sees money being spent without any real visible benefit. This makes a tempting budget-cutting target if money becomes scarce!

So, if insulation damage is not noticed, insulation maintenance is not viewed as important, the benefits are not well understood, and often the work that does get done is expensive, how can we improve it? The answer is to develop a planned or strategic approach to target and fix those areas of damage with the potential for the best benefit to the facility. It is packaged in such a way to deliver the best long-term cost. What follows is an explanation of ways to get it done.

- **Prioritize the facility.** Analyze the importance of the insulation systems for each section or process unit within your facility. For example, the catalytic cracker unit within an oil refinery is large, contains large equipment, piping, and vessels and utilizes some of the highest temperatures. Prioritizing this area will likely save the largest amount of thermal energy and money.
- **Prioritize the role insulation serves.** Which insulation systems are the most important and why? Is it process control, energy management improvement, freeze protection, personnel protection, or environmental emissions control? A chemical plant process unit manufacturing an aqueous chemical compound probably should be very concerned with freeze protection.
- **Define the scope.** Survey and quantify the necessary repairs, taking into account the quantity of damage, type of damage, and its physical location. This is the first step in assembling a work package that will yield the greatest benefit and lowest possible cost. A word of caution: do not assemble work packages any larger than you can reasonably afford to perform within a 2-year period.

Any period longer than this risks a work package that no longer reflects the needed repairs.

- **Package for geography.** Assemble the work according to specific geographic areas. This allows a crew of insulators to tackle a big enough job in any one area to make it worthwhile to get them there. The cost to mobilize a work group to and from any area can be from 10% to more than 20% of the total job cost.
- **Package for insulation damage.** If budget is an issue, consider performing repairs only on those insulation systems with damage that will yield the greatest benefit to the facility. Be careful with this one! If you split up the work in any one specific geographic area, you end up paying the work crew to come back time and again to perform work in the same area. Balance this need with packaging for geography, discussed above.
- **Develop specifications.** Insulation systems are not "one-size-fits-all" propositions. If you are only repairing a relatively small part of the insulation system, you probably want to consider specifying what is already installed, unless it is a hazardous, respirable fiber such as asbestos. However, if you are doing a large amount of work on any one system, consider:
  - The environment (exterior vs. interior, corrosive chemicals, temperatures, etc.)
  - The possibility for physical abuse, such as maintenance
  - Areas of regular maintenance (removable insulation systems may be needed)
  - Vibration
  - The reason for insulating (personnel protection, energy, etc.)
  - Cost and other factors.

  All these factors affect how well the insulation system will perform, how long it will last, and what it will cost. Time spent thinking about this will give you an insulation system that will last, resulting in the lowest long-term cost.
- **Get cost information.** Ideally, you should know what the work would cost prior to the start of job. A responsible contractor, particularly one with whom you already have a contract, can assist you in providing cost estimates for various jobs. This will give you valuable information in deciding how much you want to spend and how much value you think you will receive from the expenditure. Some companies believe that if you get a number of contractors together, show them the work, and request lump sum proposals from them, then you automatically get the best price. This is not always the case. Sometimes contractors may propose prices that some may think are higher than what the job should cost. Why? If it is a busy time for all contractors in a region, then manpower is scarce and the contractors may be stretched thin trying to do the work they already have. This condition often results in prices higher than normal. Again, a responsible contractor can give you estimates of what they think the job will cost, allowing you to decide to go ahead with the work, delay the work, or perform it another way.
- **Execute the work**. Consider the best way to perform this work. There are a variety of ways to perform it. Assuming you are considering using an insulation contractor, you can do it several ways. Several contractors can review the work at a pre-bid job meeting and submit lump sum bids. You can arrange to have the contractor perform this work on a "time and materials" basis, with the contractor charging for each hour of labor they spend, plus the cost of all materials and equipment used on the job.

  You could also have several contractors offer a "unit price" proposal in which the contractor proposes a fixed fee to perform a specific unit of work (e.g. per lineal foot or square foot for a specific insulation system installed on a specific surface). Each of these methods has been designed to perform cost effectively for the right kind of job under the right kind of circumstances.
- **Monitor the work.** The old saying goes, "You expect what you inspect," and that is true for insulation work. Thorough monitoring of the work for safety compliance, adherence to specifications, installation quality, scope completion, and schedule maintenance is critical to ensuring that the work has been performed according to what you requested and delivers the insulation system necessary to do the job you wanted done. Obviously, it is important for you to inspect the work. After all, no one else knows the facility like you do, along with the potential for hazards, and how to control them.

> No one else knows what needs to be done better than you, and no one else looks out for your interest better than you do. However, an insulation contractor can be a valuable partner in making sure the work is done in a satisfactory manner. Look for a contractor that has a proven and demonstrated quality process system in place. A good contractor will be happy to explain in detail its quality program.

Managing your industrial facility's insulation work in this manner may be dramatically different than what was done before. However, this approach gives you, the facility owner, the best chance to fix the most important insulation repairs that will benefit the facility the most, at the lowest possible cost for a quality job designed to last a long time. You have the added benefit of performing necessary work to maintain your facility that almost always pays you back, continues to pay for years to come, is kind to the environment, and conserves precious natural resources.